Some Investigations on Fire Accidents and Preparedness of Japan Historical Heritages

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Abstract

Japan has a great amount of historical heritages composed with various sorts of wood products. Recently, Horyuji, an world-oldest Buddhism temple and Himeji-Jo, a graceful lord castle have registrated as the World-worth Properties. Such kinds of heritages, however, have frequently caught and destroyed by fire. This paper reports some results of investigation on fi re facts and preparedness for historical properties. This survey shows the needs of preparedness against an initial stage of fire and the establishment of fire managements with man-equipment interface.

key words: historical heritage, investigation, fire facts, preparedness

1. Introduction

Japan settled every January 26 as the Fire Precaution Day for Historical Heritages in a severe lesson of Horyuji Golden Hall Fire on 26 January 1949. However, almost all heritage buildings are made of wood and constructed in the bustle of city central or on the contrary at a calm place remote from popularized area, which causes frequent fire accidents. This project is aimed at reduction of fire accidents by investigating fire issues and clarifying the reason of fire occurence or development.

2. Contents of investigation

The data sheets for investigation were divided two groups as of fire facts and state-of-the art of heritage equipped with fire facilities. The contents of each item are in the following.

For fire accidents:

・cause of fire ・place of fire origin ・rate of damages ・fire growth ・time of fire occurence ・fire managements ・usage of fire equipments ・fire fighting

For fire precaution preparedness

・fire managements ・fire equipments ・smoke control facilities ・inspection systems

3. Measures of investigations

110 fire reports of which 91 were effective and including 95 buildings. are collected from several fire departments which areallocated in Kyoto, Nara, Kobe, Kanazawa and Kamakura district.

These departments also report the-state-of-art of fire precaution for historical heritages during 1994.

4. Some results of investigation

4.1 Outline of historical buildings

Historical buildings are mostly owned by non private organizations, which indicates various preparedness for fire precaution might be compar atively easier to establish and manage in accodance wity scheduled plans.

Table-1 The percentage of heritage owners are as follows,

private	··· 11(11.6%)	public body	··· 18(18.9%)
religious body	··· 53(55.8%)	others	··· 13(13.7%)

In Japan, almost lord castle were demolished at the end of Shogun dynasity when occured around in 1870s. Here, temple means building for buddhists' worship.

Table-2 The type of buildings:

shrine	··· 28(29.5%)	residence	··· 15(15.8%)
temple	··· 33(34.7%)	others	··· 13(13.7%)
castle	··· 5(5.3%)	no answer	··· 1(1.1%)

Shrine, temple, residence etc. are generally low-rise with one stories, because they are kinds of wood structures. However, buddhism pagoda is middle-rise with 3 or 5 stories which has a needle rod at the top of its roof where sometimes fire occures by thunderstrickening.

Table-3 The percentage of max. height(m)

<3	3< <5	5< <10	10< <20	20< <25	25< <30	30<	no answer
10	39	20	5	2	2	0	17
(10.5%)	(41.1%)	(21.1%)	(5.3%)	(2.1%)	(2.1%)	(0.0%)	(17.9%)

Table-4 The percentage of floor area(m^2)

<100	100< <500	500< <1000	1000< <1500	1500< <2000	<2000	no answer
35 (36.8%)	42 (44.2%)	9 (9.5%)	2 (2.1%)	0 (0.0%)	1 (1.1%)	6

The 96.8% of investigated buildings structures is woodframe. And most roofs are covered by wood where a fire origin are made by flying brands, during an urban group fire. Traditional clay tiles are generally used for hish rank heritage buildings, and this investigation shows such kind of results.

Table-5 The percentage of roof covering materials

traditional clay tile	··· 40(42.1%)	cortex or bark	··· 26(27.4%)
miscanthus-thatch	··· 12(12.6%)	thin woodshingle	··· 4(4.2%)
copper	··· 6(6.3%)		

Table-6 The percentage of exterior claddings

wood clapboard	··· 49(51.6%)	traditional lacquer	··· 7(7.4%)
lime plastering	··· 15(15.8%)	clay	··· 13(13.7%)
stone	··· 1(1.1%)	brick	··· 1(1.1%)
others	··· 6(6.3%)	no answer	··· 3

Recently, arson fires have reached to the top numbers of fire causes, and some of passengers or worshippers are smokers who might make fire by their own high temperature cigarrets. These may have some intimate relationship with the opening time schedule of each historical buildings.

The density of people who visit heritages, may also relate to rise fire risk around them. And the location of heritage building strongly links with fire development, because of the distance conditions.

Table-7 The distribution of opening hours

24 hours	daytime only	till night	flexible	no answer
25(32.1%)	46(59.0%)	1(1.3%)	2(2.6%)	4

Table-8 The maximum population in building at peak hours

<10	10< <50	50< <100	100<200	200< <300	300< <500	500<	no answer
15 (15.8%)	16 (16.8%)	4 (4.2%)	5 (5.3%)	3 (3.2%)	3 (3.2%)	3 (3.2%)	46

Table-9 Location

downtown residential	rural in-garden	in-brush mountain-foot	in-mountain	others
15 (15.8%)	39 (41.1%)	13 (13.7%)	21 (22.1%)	3 (3.2%)	12 (12.6%)	4 (4.2%)	1 (1.1%)

Many heritage buildings have wide open spaces which are generally adequate to the access for fire fighting activities. This investigation shows maximum distances gathers within 5m, but some data show next peak point which locates at the distance of 20～40m, which might indicate the high fire risk exist in the heritages isolated from fire service station.

Table-10 Maximum distance (m) for the access of fire engins

<5	5< <10	10< <20	20< <40	40< <60	60< <80	80< <100	100<
38 (61.3%)	4 (6.5%)	5 (8.1%)	10 (16.1%)	2 (3.2%)	1 (1.6%)	0 (0.0%)	2 (3.2%)

[note] 62 buildings are accessible to fire engins

4.2 Fire investigations

According to the conditions of historical buildings mentioned above, 96.8% of the heritages are wood structures, about half of their roof coverings are made of combustible materials, and about half of the buildings are located in rural areas isolated from human notice.

Table-11 Distribution of times of fire outbreak ( ):%

0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	others
8 (8.4)	2 (2.1)	3 (3.2)		11 (11.6)		10 (10.5)		8 (8.4)				6
13 (13.7)		2 (2.1)		6 (6.3)		6 (6.3)		9 (9.5)		11 (11.6)		

Fire origins might be movable along with a change of peoples' way of life. Burning brands may be a kind of arson tools, and gas appratus a cause of a kitchen fire, whose facts must be analized in the next stage of investigations.

Table-12 Sorts of fire origins ( )%

burning brands	··· 39(41.1)	dangerous articles	··· 9(9.5)
high temperature solids	··· 3(3.2)	gas appratus	··· 14(14.7)
char appratus	··· 2(2.1)	natural desaster	··· 3(3.2)
electricity	··· 4(4.2)	others	··· 21

The characteristics of places of fire outobreak are recognized around exterior surface of heritage buildings. Roof shows the weakest part, where sometimes fire occures by the attack of childrens' play with fire works.

Table-13 Location of fire outbreaks ( )%

indoor	··· 35(36.8)	outdoor	··· 56(58.6)
in room	··· 25	cladding	··· 17
attic	··· 2	roof	··· 26
others	8	under floor	··· 5
		others	··· 12

Past confraglation suggests that flying brands have a long travelling distance and an effective power to make fire origin as mentioned below.

Table-14 Fire caused by flying brands and distance from fire origin

<3	3< <5	5< <10	10< <20	20< <50	50< <100
0	4	0	2	3	5

[note] 14 buildings caught by flying brands

There exists a high risk in historical buildings, because 24% of them were burnt down in spite of early arrival of fire brigade or volunteer pumps. However, various sorts of water are used, which indicates the importance of establishing a water network system during heritage areas.

Table-15 Rate of fire damages ( )%

burnt down	half damages	partial damages	slight	others
24	6	30	34	1
(25.3)	(6.3)	(31.6)	(35.8)	(1.1)

Table-16 Arrival time of a professional fire engin

( ) volunteer engin

	<3	3< <6	6< <9	9< <12	12< <15	15< <20	<30
arrival time	17(1)	30(7)	11(3)	5(5)	1(3)		3(2)
water splashing time aft arrival	39(11)	4(5)	6(0)	0(1)	1	(4)	

Table-17 Sorts of water for fire fighting

hydrant(a)	(a)+cistern(b)	(a)+natural(c)	(a)+(b)+(c)	(b)	(b)+(c)	(c)
13	10	5	7	9	4	5

4.3 Fire managements

In many cases, there should exist a person *ity the fire management licence for the precaution of historical heritages.

Data shows the rate of existence of licenced person is 91.7% to mandatory buildings, and the percentage of execution of fire training is 73.7%, which suggests almost buildings might reratively well managed.

Table-18 Patrolling conditions around buildings

	24hrs	daytime	night	others
self guards	38(60.3)	13(20.6)	4(6.3)	8(12.7)
entrusted				4
stay	7(33.3)	2(9.5)	7(33.3)	
patrol	5(23.8)	6(28.6)	2(9.5)	
mashine	2(9.5)			

Preparedness of fire precaution aiming at an initial stage of fire is quite important for wooden heritage buildings. However, the rate of installation of direct connection between fire station and heritage building. Even if there sounds an automatic alarm, there exists few chance to extingush fire.

Table-19 Percentage of setting fire alarms and linking to fire service

fire alarm installation		linking to fire department	
installed	68(71.6)	direct	··· 3(18.8)
automatic alarm	··· 65(68.4)	ward station	··· 2(12.5)
emergency bell	··· 2(2.1)	emergency call	··· 8(50.0)
shortcircuit alarm	··· 16(16.8)	no answer	··· 3
emergency broadcast	··· 2(2.1)		
others	··· 2(2.1)	total	··· 16/95
non-installed	··· 27(28.4)		

According to the investigation, heritage buildings are generally well equipped by various extingushing facilities. In spite of these good installations, there occures serious fire accidents. This suggests another renovative system might be requested for the preparedness of heritage buildings.

Table-20 Percentage of setting extingushing apparatus etc.

extingushing equipments		other equipments	
installed	81(85.3)	cistern	··· 29
extingusher	··· 75(78.9)	lightning rod	··· 18
indoor hydrant	··· 12(12.6)	drencher	··· 7
outdoor hydrant	··· 37(38.9)	spray cannon	··· 27
fire engin	··· 15(15.8)	others	··· 9
others	··· 3(3.2)		

Table-21 Sorts of person who detected or reported fire

first detecter		first reporter	
wards etc.	47(49.5)	wards etc.	52(54.7)
others	41	others	33
neibour	··· 14	neibour	··· 18
passenger	··· 10	passenger	··· 3
worshipper	··· 8	worshipper	··· 2
police person	··· 2	police person	··· 6
others	··· 7	others	··· 4
fire station	6	fire station	6
no answer	1	no answer	4

Table-22 Activity of fire alarms and usage of extingush systems

activity of fire alarms		sorts of extingush syatems	
activated	29	hand extingusher	28(49.1)
differential wire	16	watindoor hydrant	14(24.6)
differential spot	8	indoor hydrant	1(1.8)
smoke alarm	1	outdoor hydrant	18(31.6)
not clear	4	spraying cannon	3(5.3)
		others (city water, soil)	5(8.8)

5. Conclusion

This investigation shows Japan historical heritages are comparatively well equipped by fire detecters, alarms and extingushing facilities, and the owners have an annual schedule for fire training. In spite of these efforts, the fire risk of heritage buildins is gradually increasing. The reason may be found at the interface between humanbeing and facilities.

Traditional buildings are almost made of wood and few fire compartment, and fire rapidly blows through the heritage. A main target to establish another type preparedness will be focussed at intelligent linking person and facilities.

The coming other works are to gather more subtle data with cross sampling, aimed at obtaining effective manuals especially for securing initial stage fire activities for leaving heritages to next generation.

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